

PREHISTORIC BREEDING SITES OF NEW ZEALAND SEA LIONS (*PHOCARCTOS HOOKERI*, CARNIVORA: OTARIIDAE) AT NORTH CAPE

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Abstract. Holocene fossil bones of seals found in sand-dunes at three beaches in the North Cape area, were nearly all identified as New Zealand sea lions *Phocarctos hookeri*. They included remains of 12 small pups, several of them concentrated in confined areas, indicating that sea lions once bred at Tom Bowling Bay and Waikuku Beach. This is the first evidence of sea lions breeding in the North Island. It is assumed that the North Cape breeding sites were eliminated by the impact of Maori settlement in the area, most probably by hunting. Adult fossil sea lion bones are also reported from Te Werahi Beach (Cape Reinga) and from Ocean Beach, Bream Head.

KEYWORDS: Seal; pinniped; rookery; fossil; Holocene; extinction.

INTRODUCTION

The commonest pinniped in the temperate waters around the main islands of New Zealand is the New Zealand fur seal *Arctocephalus forsteri*. It breeds around most of the South Island, Stewart Island and on subantarctic islands south of New Zealand, with small breeding colonies in the southern North Island (Dix 1993). Next most frequent is the New Zealand (or Hooker's) sea lion *Phocarctos hookeri*, but it is presently restricted to southern New Zealand and subantarctic islands. It breeds mainly at the Auckland Islands, with hauling grounds around Stewart Island and the southern end of the South Island (King 1990).

Archaeological and palaeontological records suggest that New Zealand sea lions were once widespread from North Cape to Stewart Island (Childerhouse & Gales 1998). Bones from three sea lion pups from late Holocene dune sands in the Nelson area are the first proof that sea lions bred on the New Zealand mainland (Worthy 1994). Remains of a pup have also been found at Paturau, north-west Nelson (Worthy 1994).

In 1997 I found Holocene fossil ("subfossil") seal bones in sand-dunes in the North Cape area. There were adult bones and also the bones of several small pups. These fossil bones and the identity of the seal involved are the subject of this report.

STUDY AREA

The northern tip of the North Island has a coastline of rocky headlands linked by sandy beaches. Dunefields behind these beaches incorporate dune units of Pleistocene to Holocene age (Brook 1989). The dune fields are presently sparsely vegetated and mobile, but palaeontological evidence suggests that they were forest- or scrub-covered until Polynesian settlement about 1,000 years ago (Millener 1981). In this study, three sand-dune areas close to North Cape were searched

for bones – Tom Bowling Bay (8–9 April, 21–22 October 1997), Waikuku Beach (10 April, 20 October; Fig. 22) and Whareana Bay (22 October).

MATERIALS AND METHODS

Six days were spent searching the dunes on foot, scanning for bones exposed on the sand surface. The fossil seal bones collected during this study are listed in Appendix 1.

REFERENCE MATERIAL EXAMINED

New Zealand otariid seal bones are hard to identify because little guidance on the matter has been published, museum reference collections are incomplete and because the bones vary intraspecifically with sex and age. Fossil bones were compared with reference specimens at Auckland Museum (AIM), Auckland, and at the Museum of New Zealand (NMNZ), Wellington. The following reference material was used during this study:

A. *Phocarcos hookeri*.

ADULT: AIM M144, M146, M259, M505. NMNZ 2255, 2256, 2260, 2338, 2342, MCE1/8081.

PUP: No post-cranial bones were available, but photographs of various cranial and post-cranial bones were published by Worthy (1994).

B. *Arctocephalus forsteri*.

ADULT: AIM M506, M747–8. NMNZ 2192, 2202, 2204, 2336, 2339.

PUP: AIM M38, M223–4, M226–7, M457, M484. NMNZ 2199.

RESULTS

At Tom Bowling Bay, bones collected, or seen but not collected, indicated a minimum of 12 adult seals and five pups. At Waikuku Beach there were remains of at least four adults and seven pups, making a total for both areas of 16 adults and 12 pups. Whareana Beach yielded one adult seal.

AGE AND PRESERVATION OF THE FOSSILS

The fossils were found *in situ* and on deflation surfaces of Holocene coastal dune sands. No radiocarbon dates are available for the fossil sites. However, from stratigraphy they clearly pre-date human settlement and are in dune units formed after the post-glacial transgression and attainment of modern sea level about 6,500 years ago (Gibb 1986).

The fossil seal bones were light and brittle, lacking the density of fresh bone. Bone surfaces were broken or worn where they had been extensively exposed to the elements. The fossils were found in the same sites as demineralised fossil bones of birds, including species now extinct in the area (e.g. moas, North Island Takahe *Porphyrio mantelli*, New Zealand Quail *Coturnix novaezelandiae*, Kakapo *Strigops habroptilus* and New Zealand Crow *Palaeocorax moriorum*). Bones of tuataras (*Sphenodon*) were present – also locally extinct in historical times.

IDENTITY OF THE FOSSILS

The superficial features of many of the adult fossil bones are well preserved. The pup remains have survived less well owing to their fragility. Pup skulls are represented by incomplete disarticulated fragments, and all pup limb bones lack fused epiphyses. Most fossils were identified as sea lion (Appendix 1). A few could not be identified, but none were assigned to fur seal.

Tooth-size (adult and pup)

The post-canine teeth are large in New Zealand sea lions and small in New Zealand fur seals (King 1990: 30). Conversely, in adult skulls or mandibles of similar size the canines seem to be more massive in the fur seal than in the sea lion. These differences in tooth-size (or size of the corresponding sockets) allow two adult incomplete mandibles (M759, M790) and an adult maxillary fragment (M775) to be identified as sea lion.

M762 (associated pup bones of one individual), includes a left mandible with the distal end and teeth missing. The post-canine teeth sockets are much larger than in fur seal pup mandibles of a similar size, confirming these bones as sea lion. M782 (associated pup bones of two individuals), includes incomplete sections of two right mandibles with large post-canine sockets. Detached milk teeth associated with M782 are large, larger even than corresponding permanent teeth in fur seal pups.

Size of mandible (pup)

Sea lion pup mandibles have a dorso-ventrally deeper horizontal ramus than those of similar length belonging to fur seals, as shown in fig. 4 of Worthy (1994). Also, the ascending ramus is more substantial in the sea lion pup. The left mandible M762 agrees with sea lion on both these points.

Form of the basisphenoid (pup)

Among the skull fragments in M782 and M781 (sets of associated pup bones) are three basisphenoid bones. Though more robust than the corresponding bones in a series of fur seal pup skulls, the fossil basisphenoids are distinctly shorter. This indicates that they are not fur seal.

Humerus (adult) (Figs 1-8)

Worthy (1992) gave seven characters for diagnosing sea lion humeri, three of which were particularly convincing with the bones I examined.

One is the character that Worthy restated from Repenning & Tedford (1977) concerning the distal termination of the tuberculum majus. The end of the ridge points towards the medial edge of the trochlea in fur seals and towards its mid-point in sea lions.

Another is the proximal narrowing of the width of the humerus of fur seals (Fig. 2, arrowed), compared to a widening at the same point in sea lions (Figs 1, 3-4).

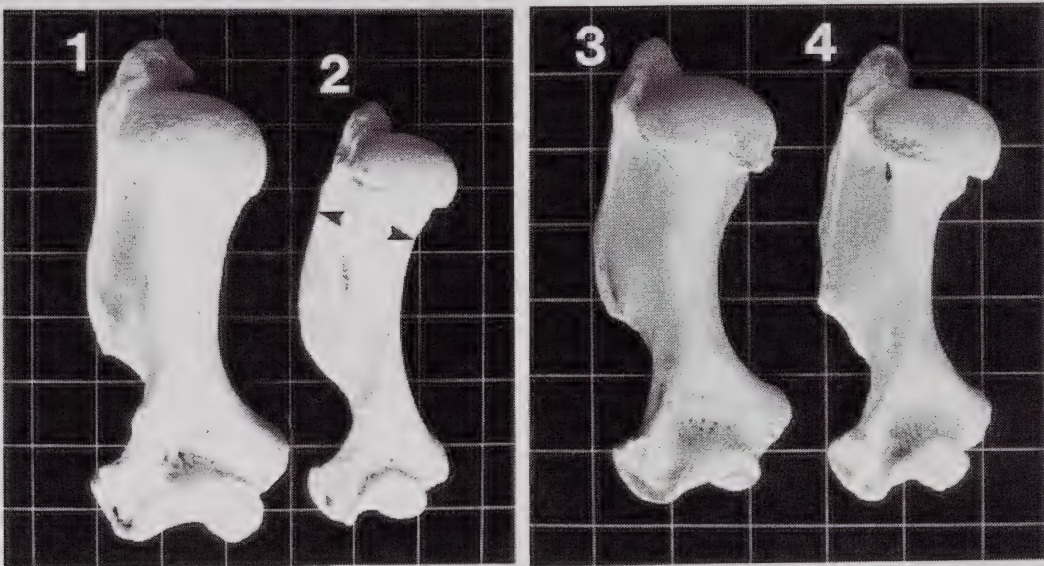
Thirdly, in sea lions the medial extremity at the distal end of the humerus (Fig. 5, point a) is much more proximal than the edge of the nearby trochlea (Fig. 5, point b). In fur seals the two points are almost level (Fig. 8, arrows). The same differences are evident in the bones viewed from the opposite side (Figs 1-4).

A further character that may prove useful is the distal end of the tuberculum majus in anterior view. The swollen face of the crest tapers distally in fur seals (Fig. 8) but swells at the distal end in sea lions (Figs 5-7; see pair of arrows in Fig. 5). A larger sample needs to be examined in case this character is age-related.

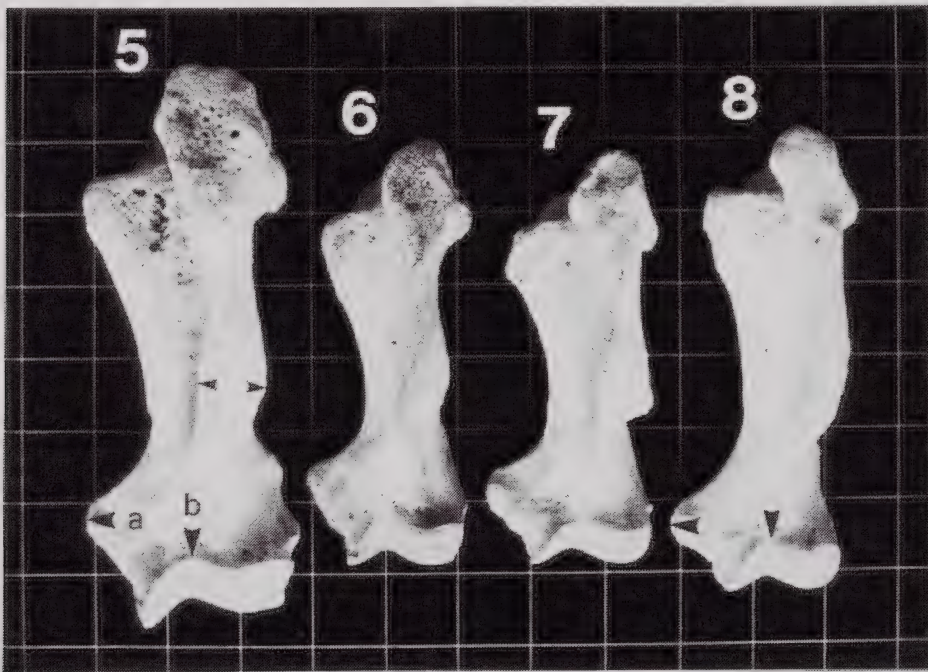
A sub-adult humerus (M780) and three adult humeri (M759-60, M783) were identified as sea lion because they agree on all the above characters.

Humerus (pup) (Figs 9-14)

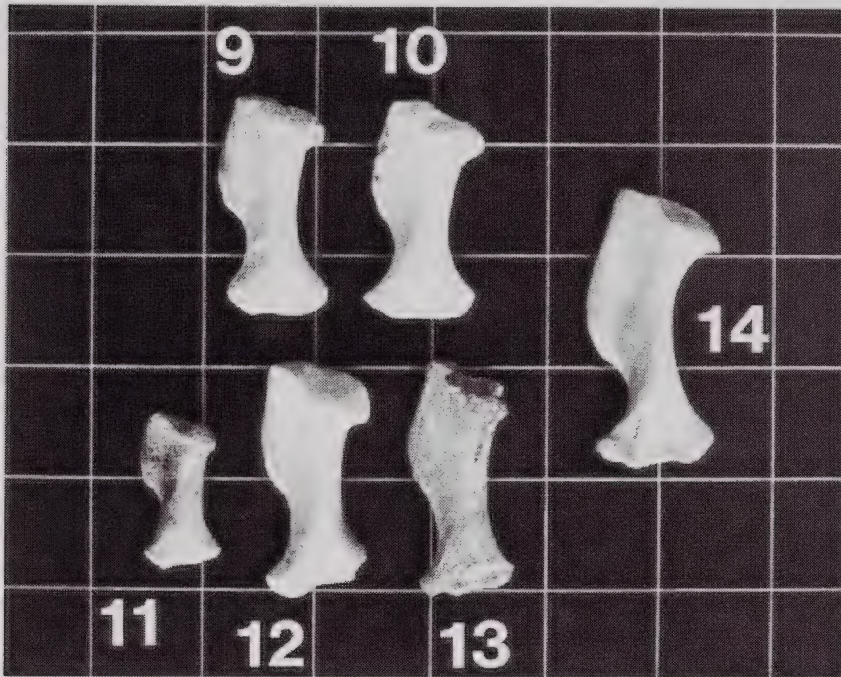
Humeri belonging to seven pups were collected (M761-2, M782 [two individuals], M787, M791, M800). Five are shown in Figs 9-13, beside an *Arctocephalus* pup humerus (Fig. 14). All



Figs 1-4. Adult left humeri in posterior view. Sides of background squares 30 mm. 1. *Phocarctos hookeri*, NMNZ 2342. 2. *Arctocephalus forsteri*, NMNZ 2339. Arrows mark the point of narrowing in this species not seen in *Phocarctos*. 3. Fossil, AIM M759. 4. Fossil, AIM M760.



Figs 5-8. Adult left humeri in anterior view. For explanation of arrows see text. Sides of background squares 30 mm. 5. *Phocarctos hookeri*, NMNZ 2342. 6. Fossil, AIM M759. 7. Fossil, AIM M760. 8. *Arctocephalus forsteri*, NMNZ 2339.



Figs 9-14. Pup left humeri in posterior view (epiphyses missing). Sides of background squares 30 mm. 9. Fossil, AIM M762. 10. Fossil, AIM M761. 11. Fossil, AIM M787. 12. Fossil, AIM M789. 13. Fossil, AIM M782. 14. *Arctocephalus forsteri*, AIM M484.

fossils are stouter than the fur seal bone, and are identified as belonging to sea lions. The tuberculum majus is particularly robust in the fossils, despite their small size and wear. Worthy (1994) also noted the robustness of the tuberculum majus in sea lion pup humeri. The total lengths of the pup humeri are given in Table 1.

Radius (adult) (Figs 15-17)

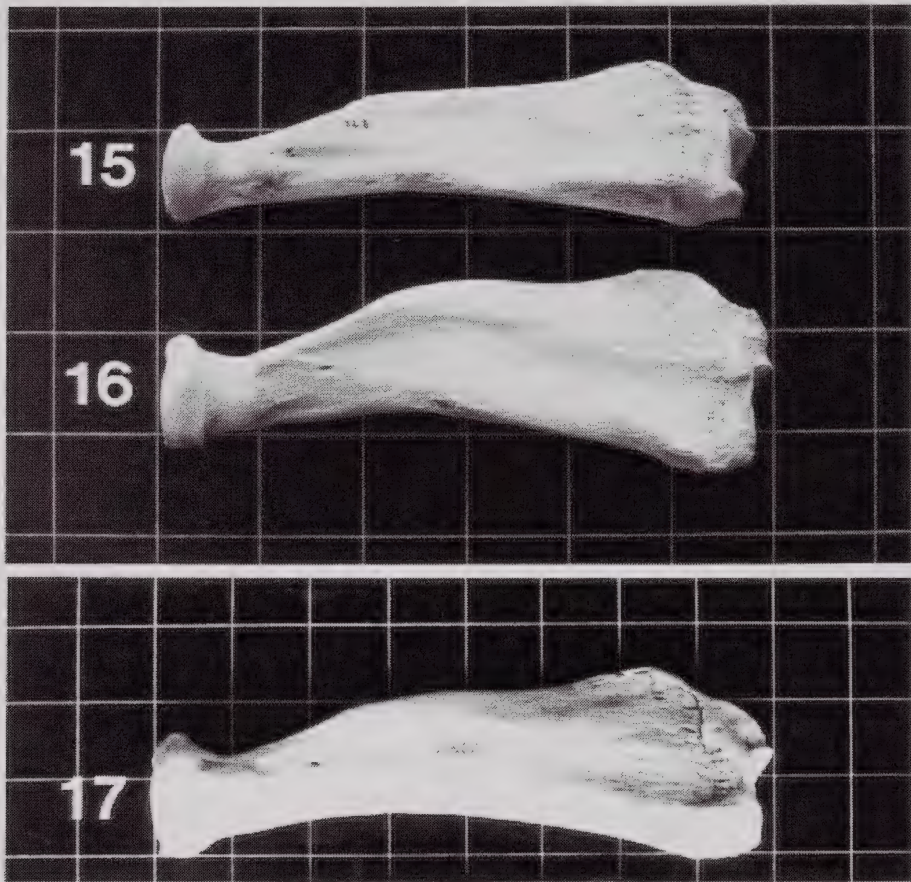
The radius of sea lions (Fig. 17) seems to be wider at its mid section, relative to its length, than is the case in fur seals (Fig. 15). All three adult-sized fossil radii (M760, M777-8) are identified as sea lion on the basis of this and other points of similarity in shape.

Radius (pup)

Radii belonging to six pups were collected (M761-2, M781, M782 [two individuals], M779). They do not show the greater relative width apparent in adult sea lions, so they cannot be independently identified to species here. The total lengths of the pup radii are given in Table 1.

Femur (adult) (Figs 18-21)

The femur of fur seals (Fig. 21) is more slender than that of sea lions (Fig. 18). Both ends of the femur of sea lions are more greatly enlarged in relation to shaft width than is the case for fur seals. In sea lions it seems there is always a prominence (the lesser trochanter) to the medial side of the shaft, just below the femoral neck, and a little posterior to it (Fig. 18, arrowed). The



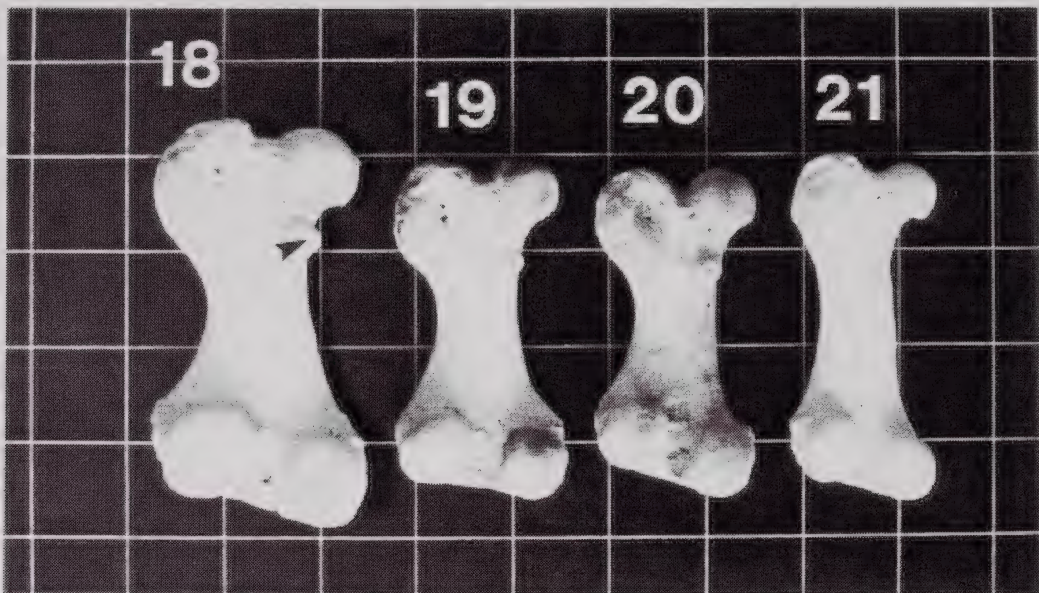
Figs 15-17. Adult left radii. Sides of background squares 30 mm. 15. *Arctocephalus forsteri*, AIM M748. 16. Fossil, AIM M760. 17. *Phocarcos bookeri*, NMNZ 2342.

lesser trochanter is often weak or absent in fur seals, being strongly developed only in large adults.

Fossil femurs belonging to five adult-sized seals were found (M758-9, M777, M783, M786). All are robust (Figs 19, 20), with strongly developed lesser trochanters, indicating that they belonged to sea lions. Those intact enough to be measured were as follows (maximum length, minimum shaft width in posterior view): M758 (104 mm, 25 mm), M759 (101, 25), M777 (110, 25), M783 (104, 24). M777 is immature—the region of union of the epiphyses with the shaft are not fully ossified.

Femur (pup)

Femurs belonging to six pups were collected (M761-2, M781-2, M788, M791). Though lacking fused epiphyses they all show evidence of the well-developed lesser trochanter typical of adult sea lions, and are identified as that species. The total lengths of the pup femurs are given in Table 1.



Figs 18-21. Adult left femurs in posterior view. Sides of background squares 30 mm. 18. *Phocarcotus hookeri*, NMNZ 2338. The arrow marks the lesser trochanter, prominent in *Phocarcotus* of all ages but weak or absent in most *Arctocephalus*. 19. Fossil, AIM M777. 20. Fossil, AIM M759. 21. *Arctocephalus forsteri*, NMNZ 2339.

Table 1. Measurements (mm) of the total length of pup limb bones from the North Cape area. All are identified as sea lion (see text), or assumed to be this species. Where both the left and right element in an individual were found, the least damaged was measured.

Element	Mean	n	s.d.	Range
humerus	55.9	7	7.56	41.5-62.2
radius	67.2	5	4.61	60.0-71.8
ulna	-	2	-	76.7, 77.4
femur	38.4	6	4.07	32.5-43.5

EVIDENCE OF BREEDING

Bones belonging to 12 seal pups were found (but not all collected) at Tom Bowling Bay and Waikuku Beach, and nine of these are identified as sea lion (Appendix 1). All bones are of a size to have belonged to either full-term foetuses or young pups. In either case they indicate breeding sites at these two beaches, because females in the late stages of pregnancy gather at rookeries and neonates remain at rookeries for their first few months (King 1990).

Most pup bones were found in clusters representing the remains of single individuals. One group of bones from Tom Bowling Bay (M782) is the combined remains of two pups of similar age which must have died together at the same spot. In the area of Waikuku Beach shown in Fig. 22, remains of five pups were found in a 500-metre strip of dunes parallel to the shore. Remains of two of these pups, c. 100 m from the present high-tide mark (left pair of arrows in



Fig. 22. Waikuku Beach looking south, 20 October 1997. Three arrows mark points at which individual pup skeletons were found.

Fig. 22), were 2.5 m apart. At Tom Bowling Bay just west of the Waiwhero Stream, remains of three pups were found in a narrow area 250-350 m from the present high-tide mark. The concentration of pup remains in confined areas is further evidence of breeding sites.

OTHER NEW RECORDS OF SEA LIONS

During this study, Holocene fossil sea lion bones from two other North Island sites were recognised, and provide additional distributional records. AIM M37 is a right femur (maximum length = 99.6 mm, minimum shaft width = 26.7 mm) from dunes behind Ocean Beach, Bream Head (coll. P.J. Miller Jan. 1984). AIM M753 is a phalanx and right humerus (total length = 231 mm) from Te Werahi Beach, Cape Reinga (coll. M.K. Eagle Jan. 1997).

DISCUSSION

The presence of bones of very small pups is evidence enough that seals bred in the North Cape area. The high number of pups among the seal bones reported in this study (minimum numbers of individuals: 17 adults, 12 pups), and this from only two site examinations, implies the existence of reasonably large breeding colonies. This is the more so because pup bones are less durable than adult bones (Worthy 1994), being small and incompletely ossified. It is unlikely that pup bones in such numbers relative to adult bones would result from just a few females returning to breed in successive years.

New Zealand sea lions breed on flat, sandy beaches or adjacent vegetated areas, unlike fur seals which prefer rocky coasts (King 1990). Both Tom Bowling Bay and Waikuku Beach are

large, flat, sandy beaches that are likely to have provided good breeding sites for large sea lion rookeries. The hinterland was probably covered in forest or scrub before Polynesian settlement c. 1,000 years ago. The sea lion colonies were presumably on the beaches and foredunes but also extending inland into forest and scrub. Sea lions can move up to 5 km inland (Worthy 1992), over hills and through dense forest (King 1990).

Millener (1981) showed that Polynesian settlement in the Far North was followed by widespread destruction of scrub and forest on the dune fields and the local extinction of many species of land vertebrates. Hunting was probably a major factor in the demise of the larger species like moas and seals. In New Zealand, sea lion remains have been found in Maori middens, indicating that they were eaten (Childerhouse & Gales 1998). It is thought that sea lions disappeared from the northern North Island by about AD1500 (unpublished thesis by Smith 1985, quoted by Worthy 1992).

The discovery of prehistoric sea lion rookeries at North Cape adds to the growing evidence that sea lions had resident populations at suitable sites throughout both main islands. The most plausible explanation for the disappearance of sea lions from much of the New Zealand coast is that they were hunted out by Maori settlers, as discussed by Worthy (1992) and Childerhouse & Gales (1998).

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APPENDIX 1. Fossil seal bones from sand-dunes near North Cape collected for this study. Abbreviations: L = left side, R = right side, hum. = humerus, rad. = radius, fem. = femur, + = other bones (ribs, hand bones, foot bones).

A. *Phocarcos hookeri* (adult).

Tom Bowling Bay. M758 (1L fem., +); M759 (1R mandibular section, 1L hum., 1L1R fem.); M775 (1L maxillary fragment, +); M777 (1R rad., 1L fem.); M778 (1R rad.); M780 (1R hum.); M786 (1R fem.); M789 (1L ulna, +); M790 (1L mandibular section).

Waikuku Beach. M760 (1L hum., 1L rad.).

Whareana Bay. M783 (1R hum., 1L1R fem.).

B. *Phocarcos hookeri* (pup).

Tom Bowling Bay. M782 (skull fragments, 2R mandibles, 1L2R hum., 2L1R rad., 1R fem. [two individuals]); M787 (1L hum.); M788 (1L fem.); M791 (1R hum., 1L fem.); M800 (1L hum.).

Waikuku Beach. M761 (1L1R hum., 1L1R rad., 1L1R ulna, 1L1R fem. [one individual]);

M762 (1L mandibular section, 1L1R hum., 1L1R rad., 1R ulna, 1R fem. [one individual]);

M781 (skull fragments, 1L rad., 1R fem.).

C. Unidentified pinniped (adult).

Tom Bowling Bay. M774 (+); M776 (1L hum.).

Waikuku Beach. M785 (1L hum., +).

D. Unidentified pinniped (pup).

Waikuku Beach. M779 (1R rad.).